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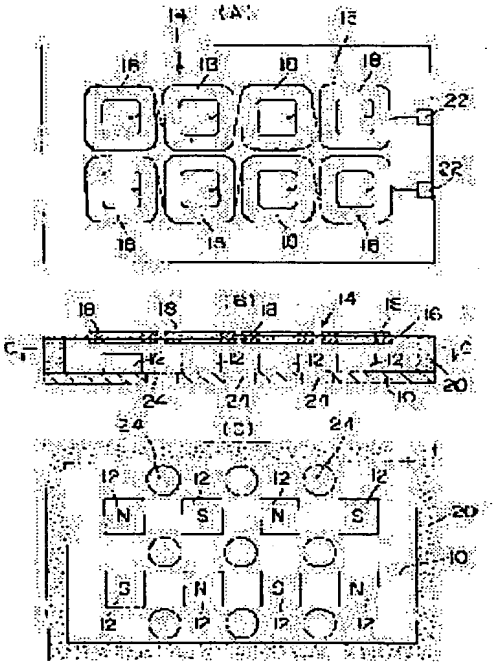
(54) PLANE LOUDSPEAKER

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a plane loudspeaker equipped with a yoke flat board 10, permanent magnets 12 fitted to one side of the yoke 10 where the magnets adjacent to each other have opposite polarities, a vibrating membrane 14 where spiral coils are formed on both sides of a base film 16 in a way that adjacent sides of the adjacent spiral coils receive currents in the same direction and a speaker 20 that holds the vibrating membrane 14 by a prescribed distance from the magnetic pole face of the permanent magnets 12 that prevents the vibrating membrane 14 from being slacked so as to reduce deterioration in the sound quality.
SOLUTION: A liquid crystal polymer film is used for a base film 16 of a vibrating membrane 14. Since the liquid crystal polymer film has an excellent size stability against a temperature rise and has a considerably lower hygroscopicity that that of a conventional resin film, a slack hardly takes place in the vibrating membrane using the liquid crystal polymer for its base film even for use for a long time and the deterioration in the sound quality can be reduced.



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CLAIMS

[Claim(s)]
[Claim 1] The permanent magnet attached in York (10) which has a plate-like part at least, and this York (10) (12), The vibrating membrane formed in one side or both sides of an insulating base film (16) so that the field which counters the curled form coil (18) corresponding to said permanent magnet (12) with the magnetic pole of said permanent magnet (12) might be surrounded (14), In the flat-surface loudspeaker equipped with the attachment component (20) which detaches only a predetermined distance and holds this vibrating membrane (14) from York of said permanent magnet (12), and the pole face of the opposite side The flat-surface loudspeaker characterized by the base film (16) of said vibrating membrane (14) consisting of a liquid crystal polymer film.
[Claim 2] The flat-surface loudspeaker according to claim 1 characterized by having stuck the buffer sheet (30) on York of a permanent magnet (12), and the pole face of the opposite side, and preparing an opening (G) between this buffer sheet (30) and vibrating membrane (14).
[Claim 3] The flat-surface loudspeaker according to claim 1 or 2 characterized by putting a coat (26) so that a curled form coil (18) and a base film (10) may be covered to the field in which the curled form coil (18) of vibrating membrane (14) is formed.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a thin flat-surface loudspeaker.
[0002]
[Description of the Prior Art] A flat-surface loudspeaker like drawing 6 is indicated by the international public presentation WO 99/No. 03304 official report. In drawing, plate-like York where 10 consists of a griddle (ferromagnetic metal plate), and 12 are two or more permanent magnets attached in one side of York 10 by making a magnetic axis perpendicular. The permanent magnet 12 is attached so that predetermined spacing may be set in the direction of a flat surface of York 10 and a polarity may become opposite into next doors.
[0003] Moreover, 14 is the vibrating membrane by which only a predetermined distance was detached and held from York 10 of a permanent magnet 12, and the pole face of the opposite side. This vibrating membrane 14 makes said two or more permanent magnets 12 correspond to both sides (for one side to be also good) of the insulating base film 16, and forms two or more curled form coils 18 in them. Each curled form coil 18 is formed so that the magnetic pole of a permanent magnet 12 and the field which counters may be surrounded, and so that it may flow the adjoining side of an adjacent coil in the direction where a current is the same.
[0004] The circuit pattern of the curled form coil 18 has become like drawing 7 . 18n1 The coil and 18n2 which were formed in the front face of a base film 16 It is the coil formed in the location where the rear face of a base film is the same. coil 18n1 of a front face it forms in a curled form so that it may go to the inside by the clockwise rotation from an outside — having — coil 18n2 of a rear face it forms in a curled form so that it may go outside by the clockwise rotation from the inside — having — both — coil 18n1 and 18n2 It has flowed through an inner edge in the through hole or through stud which penetrates a base film. therefore — both — coil 18n1 and 18n2 The winding direction constitutes one clockwise coil 18.
[0005] Moreover, 18m1 It is said coil 18n1 to the front face of a base film 16. The coil and 18m2 which were formed so that each other might be adjoined It is said coil 18n2 to the rear face of a base film 16. It is the coil formed so that each other might be adjoined. coil 18m2 of a rear face an outer edge — the next coil 18n2 it is continuing, and it forms in a curled form so that it may go to the inside by the counterclockwise rotation from an outside — having — coil 18m1 of a front face it forms in a curled form so that it may go outside by the counterclockwise rotation from the inside — having — both — coil 18m1 and 18m2 It has flowed through an inner edge in the through hole or through stud which penetrates a base film. therefore — both — as for coil 18m1 and 18m2, the winding direction constitutes one counterclockwise coil 18.
[0006] When two or more curled form coils 18 in such a form are formed in the shape of a picture drawn without lifting the brush from the paper, it will flow the adjoining side of the adjacent coils 18 and 18 in the direction where a current is the same. On the other hand, since each coil 18 is placed into the field formed with the permanent magnet 12 with which the polarities which adjoin each other mutually differ as shown in drawing 6 , when a current flows in the direction same the adjoining side of the adjacent coil 18, vibrating membrane 14 will receive electromagnetic force with the left-hand rule of Fleming. In drawing 7 , H is a field formed of the magnetic poles N and S of a permanent

magnet 12, and when the current of the direction of an arrow head flows in a coil 18 in this condition, the force of the direction of F will occur. For this reason, vibrating membrane 14 vibrates according to the speech current which flows in a coil 18.

[0007] Since the above flat-surface loudspeakers of a type can make thickness thin to about 5-15mm, they are suitable for a flat TV, a notebook computer, etc. Moreover, the inclusion to a pillar, a sun visor, etc. of an automobile also becomes possible.

[0008]

[Problem(s) to be Solved by the Invention] However, the curled form coil occupies the field of the great portion of vibrating membrane, and since each coil generates heat with the Joule's heat, the flat-surface loudspeaker of the above-mentioned type cannot disregard effect of the heat to the base film which is the base material of vibrating membrane. For this reason, it is a polyimide film although using a heat-resistant good polyimide film for a base film is proposed. tandelta=0.02 and absorption-of-sound nature are low, and when vibrating membrane vibrates, there is a problem of being easy to generate a noise. Moreover, since a polyimide film has hygroscopicity, change of the tone quality resulting from the slight elongation by moisture absorption is expected.

[0009] Moreover, using a PET (polyethylene terephthalate) film for a base film is proposed, and it is also a PET film. tandelta=0.014 Absorption-of-sound nature is low, and when vibrating membrane vibrates, there is a problem of being easy to generate a noise.

[0010] Moreover, the flat-surface loudspeaker of the above-mentioned type may contact a permanent magnet, when vibrating membrane vibrates greatly, and a noise may be generated. This problem will become remarkable if looseness occurs in vibrating membrane by generation of heat of the coil mentioned above. Although it is well-known to also make elasticity material, such as urethane foam and glass wool, intervene between vibrating membrane and a permanent magnet as a means to prevent this, making such elasticity material intervene will bar a free vibration of vibrating membrane, and it becomes the factor which reduces tone quality.

[0011] Moreover, although the vibrating membrane in which two or more curled form coils were formed to one side or both sides of a base film can be manufactured by the manufacturing technology of the usual flexible printed circuit substrate, since a coil vibrates violently in the thickness direction in response to electromagnetic force, if the adhesive strength of a base film and a coil is not quite strong, in the case of vibrating membrane, there is a possibility that a coil may exfoliate from a base film. In order to prevent exfoliation of a coil, it is effective to split-face-ize a base film front face, and to heighten the adhesive strength per unit area, or to make the conductor width of a coil large, but the former has a limitation, when a thin base film is used for the improvement in an oscillation characteristic, and since the latter causes enlargement of a flat-surface loudspeaker, it is not desirable.

[0012] In view of the above troubles, it is hard to generate looseness of vibrating membrane, therefore the first purpose of this invention has it in offering a flat-surface loudspeaker with little degradation of tone quality. The second purpose of this invention loses the contact sound of vibrating membrane and a permanent magnet, and is to offer the flat-surface loudspeaker which moreover does not bar a free vibration of vibrating membrane. The third purpose of this invention is to offer a reliable flat-surface loudspeaker with few possibilities that the curled form coil of vibrating membrane may exfoliate from a base film.

[0013]

[Means for Solving the Problem] York where this invention has a plate-like part at least in order to attain said first purpose, The vibrating membrane formed in the permanent magnet attached in this York, and one side or both sides of an insulating base film so that the field which counters the curled form coil corresponding to said permanent magnet with the magnetic pole of said permanent magnet might be surrounded, In the flat-surface loudspeaker equipped with the attachment component which separates only a predetermined distance from York of said permanent magnet, and the pole face of the opposite side, and holds this vibrating membrane, it is characterized by the base film of said vibrating membrane consisting of a liquid crystal polymer film.

[0014] This invention more specifically so that a magnetic axis may become perpendicular at one side of the plate-like parts of York which has a plate-like part at least, and this York And so that two or more permanent magnets attached so that a polarity might become opposite into next doors, and the

field which counters two or more curled form coils which are equivalent to said two or more permanent magnets by one side or both sides of an insulating base film with the magnetic pole of said permanent magnet may be surrounded And the vibrating membrane formed so that it might flow the adjoining side of an adjacent curled form coil in the direction where a current is the same, In the flat-surface loudspeaker equipped with the attachment component which only a distance predetermined [York of two or more of said permanent magnets and the pole face of the opposite side to] detaches this vibrating membrane, and is held, it is characterized by constituting the base film of said vibrating membrane from a liquid crystal polymer film.

[0015] a liquid crystal polymer film has the dimensional stability which was excellent to the temperature rise, hygroscopicity is markedly alike from the usual resin film, also by prolonged use, it is hard to generate looseness and the vibrating membrane which is low (for example, a liquid crystal polymer is 0.04% to the polyimide of the rate of hygroscopic swelling being 2.9 %) one, and used this as a base film can lessen degradation of tone quality. Moreover, liquid crystal polymer film Since tandelta (an internal loss, absorption-of-sound nature) is high, there is also an advantage of being hard to generate a noise.

[0016] Moreover, in order that this invention may attain said second purpose, in the flat-surface loudspeaker of the above-mentioned configuration, it sticks a buffer sheet on York of a permanent magnet, and the pole face of the opposite side, and is characterized by preparing an opening between this buffer sheet and vibrating membrane. If it does in this way, even if vibrating membrane becomes the amplitude which a free vibration is not barred and moreover contacts the pole face, it can control generating of a contact sound by work of a buffer sheet.

[0017] Moreover, this invention is characterized by putting a coat so that a curled form coil and a base film may be covered to the field in which the curled form coil of vibrating membrane is formed in the flat-surface loudspeaker of the above-mentioned configuration in order to attain said third purpose. Since a curled form coil will be in the condition of having been pressed down by the base film, with a coat if it does in this way, even if it receives an intense vibration, a possibility that a coil may exfoliate from a base film decreases.

[0018]

[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained to a detail with reference to a drawing.

[Operation gestalt 1] Drawing 1 (A) - (C) shows 1 operation gestalt of this invention. In drawing, plate-like York where 10 consists of a griddle etc., and 12 are two or more permanent magnets attached in one side of York 10 by making a magnetic axis perpendicular. The permanent magnet 12 is attached so that predetermined spacing may be set in the direction of a flat surface of York 10 and a polarity may become opposite into next doors.

[0019] Moreover, the vibrating membrane by which 14 comes to form two or more curled form coils 18 corresponding to said two or more permanent magnets 12 in both sides of a base film 16, and 20 are frame type spacers (attachment component) which detach only a predetermined distance and hold vibrating membrane 14 from the pole face of a permanent magnet 12. Each curled form coil 18 of vibrating membrane 14 is formed so that the magnetic pole of the permanent magnet 12 of a base film 16 and the field which counters may be surrounded, and so that it may flow the adjoining side of the adjacent curled form coil 18 in the direction where a current is the same. It is formed with a concrete for example, circuit pattern like drawing 7 . As for a spacer 20, it is desirable to constitute, elastic ingredient, for example, chloroprene foam etc., etc. In addition, it is the hole which formed 22 in York 10 at the input terminal of a coil 18, and formed 24 for the air vent.

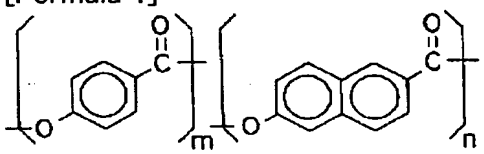
[0020] The description of this flat-surface loudspeaker is that the base film 16 which is the base material of vibrating membrane 14 consists of liquid crystal polymer films. Since the liquid crystal polymer film is excellent in thermal resistance, the dimensional stability (the coefficient of thermal expansion of 15-20 ppm/degree C, measurement result of 30 - 150 ** by the apparatus for thermomechanical analysis) which was excellent even if the curled form coil 18 carried out the temperature rise with the Joule's heat is shown, and coefficient of linear expansion is close to copper. Furthermore, since hygroscopicity is low (0.04% of water absorption, 23 degrees C, 24H), a liquid crystal polymer film is excellent in moisture absorption dimensional stability (rate of moisture absorption dimensional change 4 ppm/%RH in 60 degrees C), and even if it carries out long duration

use, it does not almost have degradation of tone quality. Moreover, the absorption-of-sound nature of a liquid crystal polymer film is also high (tandelta=0.06). It is that and generating of a noise can be lessened.

[0021] As a liquid crystal polymer which constitutes the base film 16 of this flat-surface loudspeaker, the copolymerized polyester of the principal chain mold which contains as a principal component, the liquid crystal polymer (PHB), for example, Para-hydroxybenzoic acid, of all aromatic polyester systems, is desirable. The copoly ester types (trade name: Vectra etc.) of PHB and a 6-oxy-2-naphthoic acid are desirable especially. The chemical structure type of Vectra is as follows.

[0022]

[Formula 1]



[0023] Moreover, as for the base film 16 of this flat-surface loudspeaker, what carried out inflation molding of said liquid crystal polymer, and made orientation of a molecule isotropic in the direction of a field is desirable. After supplying a gas to that building envelope and making it expand with internal pressure, specifically extruding the fused liquid crystal polymer in the shape of a cylinder, forming a cylindrical film, and cooling this film, it is good to cut it open along with the direction of extrusion, to judge from what was used as the flat film-like film, and to consider as a base film 16.

[0024] Moreover, although it is also possible to adopt a subtractive process (how to carry out pattern etching of the copper-clad laminated film, and form a circuit pattern) as usual in order to form the curled form coil 18 on a liquid crystal polymer film, it is desirable to adopt an additive process (base film electroless deposition or the approach of forming a circuit pattern according to concomitant use of electroless deposition and electrolytic plating). In a subtractive process, the dimensional stability of a circuit pattern is low under the effect of side etching, and although it is difficult to make variation in the impedance of a coil small, if it is an additive process, since the dimensional stability of a circuit pattern is high, the variation in the impedance of a coil can be suppressed smaller.

[0025] [Operation gestalt 2] Drawing 2 (A) and (B) show other operation gestalten of this invention. With this operation gestalt, peripheral wall section 10a and shelf 10b are formed in the perimeter of the monotonous section of York 10 at one, and York 10 has become a shallow core box.

[0026] Moreover, the coat 26 is put on both sides of vibrating membrane 14 so that a base film 16 (liquid crystal polymer film) and the curled form coil 18 may be covered. This coat 26 presses down the curled form coil 18 to a base film 16, and serves to prevent that the curled form coil 18 exfoliates from a base film 16 by vibration. As a coat 26, an adhesive property with a liquid crystal polymer film is good, and can use the coating which consists of heat-resistant high insulating resin. For example, the coating of an alkyd-resin system, the thing which specifically denaturalized with the oil or the fatty acid on the basis of the alkyd resin (ester of polybasic acid, such as a phthalic acid, and polyhydric alcohol, such as a glycerol) can be used.

[0027] Moreover, vibrating membrane 14 is held in the periphery by the frame-like attachment component 28 which has elasticity. Wave section 28a to carry out adhesion immobilization of the inner circumference section at the periphery of vibrating membrane 14, carry out adhesion immobilization of the periphery section at shelf 10b of York 10, and for an attachment component 28 raise elasticity between the inner circumference section and the periphery section is formed. If vibrating membrane 14 is held by such attachment component 28, the reflected wave from the edge section by vibration of vibrating membrane 14 decreases, and improvement in tone quality can be aimed at.

[0028] Moreover, the buffer sheet 30 is stuck on the pole face of the York 10 and the opposite side of a permanent magnet 12, and Opening G is formed between this buffer sheet 30 and vibrating membrane 14. If it is made such a configuration, also when there is an opening G, vibration of vibrating membrane 14 is not checked, and there is a buffer sheet 30 and vibrating membrane 14 vibrates greatly to extent in contact with a permanent magnet 12, generating of a contact sound can

be controlled. For this reason, improvement in tone quality and control of a noise can be aimed at. A nonwoven fabric, Japanese paper, etc. can be used as a buffer sheet 30.
[0029] in addition, the input terminal 22 of vibrating membrane 14 obtains that it is good for the external terminal 34 attached in the external surface of York 10 through the electric insulating plate 32, and is electrically connected to it by the conductor 36. As specifically shown in drawing 2 (C), through tube 16a is formed in the base film 16 of the part in which the input terminal 22 of vibrating membrane 14 was formed, and the patterns 22b and 22c of a front flesh side are combined by through hole plating 22d. It is preventing that an input terminal 22 exfoliates from a base film 16 by this. moreover, it obtains that it is good, and a conductor 36 pierces through through tube 16a, and is being fixed with solder 23. Since configurations other than the above are the same as the operation gestalt 1, the same sign is given to the same part and explanation is omitted.
[0030]
[Example] [Example 1] The liquid crystal polymer film (Kuraray CT) with a thickness of 50 micrometers, the polyimide film, and the PET film were used for the base film of vibrating membrane, and the flat-surface loudspeaker with width of face of 40mm, a die length [of 140mm], and a thickness of 7mm was made as an experiment. To plate-like York 10 which formed the hole 24 like drawing 1 , with the square of 9mm around, the pole face has arranged 24 neodium magnets with a thickness of 3mm by arrangement of 2 train x12 line so that a polarity may become opposite into next doors.
[0031] The circuit pattern of vibrating membrane 14 was manufactured with the additive process. That is, wet-blasting processing was first performed to the base film as split-face-ized processing. Next, punching processing was performed in the location (the through hole section, terminal area) used as the double-sided flow section of a base film. Punching processing is performed to a terminal area for connecting a double-sided terminal area and raising the peel strength of a terminal area. Then, the vibrating membrane which has 20 curled form coils to both sides was manufactured through a non-electrolytic copper plating process, plating resist presswork, the electrolytic copper plating process, the plating resist removal process, the etching process, and the coat spreading process. The impedance between terminals was set as 6 ohms. As shown in drawing 1 , this vibrating membrane carried out adhesion immobilization of the spacer 20 which becomes the periphery section of plate-like York 10 from chloroprene foam with a thickness of 5mm, and carried out adhesion immobilization on that spacer 20. It considered as the structure which keeps constant the distance of vibrating membrane 14 and the pole face of a permanent magnet 12 by this.
[0032] About each flat-surface loudspeaker made as an experiment, the sinusoidal signal of 300 mV is added in 20kHz from 20Hz, and the result of having measured sound pressure-frequency characteristics is shown in drawing 3 and drawing 4 . Drawing 3 is the test result of the flat-surface loudspeaker of this invention which used the liquid crystal polymer film for the base film, and the sound pressure property before a carries out a heat cycle test and moisture resistance, and the sound pressure property after b carries out both trials are shown. A heat cycle test and moisture resistance are in the condition which impressed the white noise of 10W, and followed the conditions of automobile specification (JASO (D 001-94)). Both have almost lapped and it turns out that the flat-surface loudspeaker of this invention which used the liquid crystal polymer film for the base film does not almost have change in a sound pressure property before and behind a trial so that clearly from a and b of drawing 3 .
[0033] Drawing 4 is the test result of the flat-surface loudspeaker which used the polyimide film for the base film, and the sound pressure property before c carries out a heat cycle test and moisture resistance, and the sound pressure property after d carries out both trials are shown. A sound pressure property changes before and after a trial, and, as for the flat-surface loudspeaker which used the polyimide film for the base film, the fall of sound pressure is accepted after a trial. The flat-surface loudspeaker which used the PET film was also the same result as this.
[0034] [Example 2] Using three kinds of same base films as an example 1, the laminating of the copper foil with a thickness of 18 micrometers was carried out to both sides of each base film, and the curled form coil was formed in them with the subtractive process. It was made to flow through the through hole section electrically in coppering. The impedance between terminals was also set to the same 6 ohms as an example 1. Thus, the flat-surface loudspeaker of the same size as an example

1 was made as an experiment using the manufactured vibrating membrane. As a result of measuring a sound pressure property about each flat-surface loudspeaker, the almost same property as drawing 3 was acquired, and the difference of the sound pressure property by the difference in the manufacture approach of vibrating membrane was not accepted. However, in the case of the subtractive process, compared with the case of an additive process, since the dimensional stability of a curled form coil was low, it was easy to generate variation in the impedance between terminals, and it turned out that it is difficult to manufacture a 6-ohm thing correctly.

[0035] [Example 3] The flat-surface loudspeaker which used the liquid crystal polymer film (Kuraray CT) with a thickness of 50 micrometers for the base film of vibrating membrane, and the flat-surface loudspeaker using an aramid nonwoven fabric reinforcement bridge formation polyester sheet (the Toyobo KOSUMO flex time) were made as an experiment. The curled form coil of vibrating membrane was formed with the subtractive process. The result of having measured the sound pressure property about these flat-surface loudspeakers is shown in drawing 5 . The sound pressure property of the flat-surface loudspeaker of this invention that a used the liquid crystal polymer film, and e are the sound pressure properties of the flat-surface loudspeaker of the example of a comparison which used the aramid nonwoven fabric reinforcement bridge formation polyester sheet. It turns out that the flat-surface loudspeaker of this invention is excellent in the sound pressure property of a loud-sound field compared with the flat-surface loudspeaker of the example of a comparison.

[0036]

[Effect of the Invention] As explained above, by having used the liquid crystal polymer film for the base film of vibrating membrane, also under a humid environment, looseness of vibrating membrane is hard to be generated, therefore, according to this invention, degradation of tone quality can obtain few flat-surface loudspeakers.

[0037] Moreover, by sticking a buffer sheet on York of a permanent magnet, and the pole face of the opposite side, and preparing an opening between this buffer sheet and vibrating membrane, the contact sound of vibrating membrane and a permanent magnet can be lost, and the flat-surface loudspeaker which moreover does not bar a free vibration of vibrating membrane can be obtained.

[0038] A reliable flat-surface loudspeaker with few possibilities that a curled form coil may exfoliate from a base film can be obtained by furthermore, putting a coat on the surface of vibrating membrane, so that a base film and a curled form coil may be covered.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates to a thin flat-surface loudspeaker.

[Translation done.]

PRIOR ART

[Description of the Prior Art] A flat-surface loudspeaker like drawing 6 is indicated by the international public presentation WO 99/No. 03304 official report. In drawing, plate-like York where 10 consists of a griddle (ferromagnetic metal plate), and 12 are two or more permanent magnets attached in one side of York 10 by making a magnetic axis perpendicular. The permanent magnet 12 is attached so that predetermined spacing may be set in the direction of a flat surface of York 10 and a polarity may become opposite into next doors.
[0003] Moreover, 14 is the vibrating membrane by which only a predetermined distance was detached and held from York 10 of a permanent magnet 12, and the pole face of the opposite side. This vibrating membrane 14 makes said two or more permanent magnets 12 correspond to both sides (for one side to be also good) of the insulating base film 16, and forms two or more curled form coils 18 in them. Each curled form coil 18 is formed so that the magnetic pole of a permanent magnet 12 and the field which counters may be surrounded, and so that it may flow the adjoining side of an adjacent coil in the direction where a current is the same.
[0004] The circuit pattern of the curled form coil 18 has become like drawing 7 . 18n1 The coil and 18n2 which were formed in the front face of a base film 16 It is the coil formed in the location where the rear face of a base film is the same. coil 18n1 of a front face it forms in a curled form so that it may go to the inside by the clockwise rotation from an outside — having — coil 18n2 of a rear face it forms in a curled form so that it may go outside by the clockwise rotation from the inside — having — both — coil 18n1 and 18n2 It has flowed through an inner edge in the through hole or through stud which penetrates a base film. therefore — both — coil 18n1 and 18n2 The winding direction constitutes one clockwise coil 18.
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[0007] Since the above flat-surface loudspeakers of a type can make thickness thin to about 5-

15mm, they are suitable for a flat TV, a notebook computer, etc. Moreover, the inclusion to a pillar, a sun visor, etc. of an automobile also becomes possible.

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EFFECT OF THE INVENTION

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[0038] A reliable flat-surface loudspeaker with few possibilities that a curled form coil may exfoliate from a base film can be obtained by furthermore, putting a coat on the surface of vibrating membrane, so that a base film and a curled form coil may be covered.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, the curled form coil occupies the field of the great portion of vibrating membrane, and since each coil generates heat with the Joule's heat, the flat-surface loudspeaker of the above-mentioned type cannot disregard effect of the heat to the base film which is the base material of vibrating membrane. For this reason, it is a polyimide film although using a heat-resistant good polyimide film for a base film is proposed. tandelta=0.02 and absorption-of-sound nature are low, and when vibrating membrane vibrates, there is a problem of being easy to generate a noise. Moreover, since a polyimide film has hygroscopicity, change of the tone quality resulting from the slight elongation by moisture absorption is expected.
[0009] Moreover, using a PET (polyethylene terephthalate) film for a base film is proposed, and it is also a PET film. tandelta=0.014 Absorption-of-sound nature is low, and when vibrating membrane vibrates, there is a problem of being easy to generate a noise.
[0010] Moreover, the flat-surface loudspeaker of the above-mentioned type may contact a permanent magnet, when vibrating membrane vibrates greatly, and a noise may be generated. This problem will become remarkable if looseness occurs in vibrating membrane by generation of heat of the coil mentioned above. Although it is well-known to also make elasticity material, such as urethane foam and glass wool, intervene between vibrating membrane and a permanent magnet as a means to prevent this, making such elasticity material intervene will bar a free vibration of vibrating membrane, and it becomes the factor which reduces tone quality.
[0011] Moreover, although the vibrating membrane in which two or more curled form coils were formed to one side or both sides of a base film can be manufactured by the manufacturing technology of the usual flexible printed circuit substrate, since a coil vibrates violently in the thickness direction in response to electromagnetic force, if the adhesive strength of a base film and a coil is not quite strong, in the case of vibrating membrane, there is a possibility that a coil may exfoliate from a base film. In order to prevent exfoliation of a coil, it is effective to split-face-ize a base film front face, and to heighten the adhesive strength per unit area, or to make the conductor width of a coil large, but the former has a limitation, when a thin base film is used for the improvement in an oscillation characteristic, and since the latter causes enlargement of a flat-surface loudspeaker, it is not desirable.
[0012] In view of the above troubles, it is hard to generate looseness of vibrating membrane, therefore the first purpose of this invention has it in offering a flat-surface loudspeaker with little degradation of tone quality. The second purpose of this invention loses the contact sound of vibrating membrane and a permanent magnet, and is to offer the flat-surface loudspeaker which moreover does not bar a free vibration of vibrating membrane. The third purpose of this invention is to offer a reliable flat-surface loudspeaker with few possibilities that the curled form coil of vibrating membrane may exfoliate from a base film.

[Translation done.]

MEANS

[Means for Solving the Problem] York where this invention has a plate-like part at least in order to attain said first purpose, The vibrating membrane formed in the permanent magnet attached in this York, and one side or both sides of an insulating base film so that the field which counters the curled form coil corresponding to said permanent magnet with the magnetic pole of said permanent magnet might be surrounded, In the flat-surface loudspeaker equipped with the attachment component which separates only a predetermined distance from York of said permanent magnet, and the pole face of the opposite side, and holds this vibrating membrane, it is characterized by the base film of said vibrating membrane consisting of a liquid crystal polymer film.
[0014] This invention more specifically so that a magnetic axis may become perpendicular at one side of the plate-like parts of York which has a plate-like part at least, and this York And so that two or more permanent magnets attached so that a polarity might become opposite into next doors, and the field which counters two or more curled form coils which are equivalent to said two or more permanent magnets by one side or both sides of an insulating base film with the magnetic pole of said permanent magnet may be surrounded And the vibrating membrane formed so that it might flow the adjoining side of an adjacent curled form coil in the direction where a current is the same, In the flat-surface loudspeaker equipped with the attachment component which only a distance predetermined [York of two or more of said permanent magnets and the pole face of the opposite side to] detaches this vibrating membrane, and is held, it is characterized by constituting the base film of said vibrating membrane from a liquid crystal polymer film.
[0015] a liquid crystal polymer film has the dimensional stability which was excellent to the temperature rise, hygroscopicity is markedly alike from the usual resin film, also by prolonged use, it is hard to generate looseness and the vibrating membrane which is low (for example, a liquid crystal polymer is 0.04% to the polyimide of the rate of hygroscopic swelling being 2.9 %) one, and used this as a base film can lessen degradation of tone quality. Moreover, liquid crystal polymer film Since tandelta (an internal loss, absorption-of-sound nature) is high, there is also an advantage of being hard to generate a noise.
[0016] Moreover, in order that this invention may attain said second purpose, in the flat-surface loudspeaker of the above-mentioned configuration, it sticks a buffer sheet on York of a permanent magnet, and the pole face of the opposite side, and is characterized by preparing an opening between this buffer sheet and vibrating membrane. If it does in this way, even if vibrating membrane becomes the amplitude which a free vibration is not barred and moreover contacts the pole face, it can control generating of a contact sound by work of a buffer sheet.
[0017] Moreover, this invention is characterized by putting a coat so that a curled form coil and a base film may be covered to the field in which the curled form coil of vibrating membrane is formed in the flat-surface loudspeaker of the above-mentioned configuration in order to attain said third purpose. Since a curled form coil will be in the condition of having been pressed down by the base film, with a coat if it does in this way, even if it receives an intense vibration, a possibility that a coil may exfoliate from a base film decreases.
[0018]
[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained to a detail with reference to a drawing.

[Operation gestalt 1] Drawing 1 (A) – (C) shows 1 operation gestalt of this invention. In drawing, plate-like York where 10 consists of a griddle etc., and 12 are two or more permanent magnets attached in one side of York 10 by making a magnetic axis perpendicular. The permanent magnet 12 is attached so that predetermined spacing may be set in the direction of a flat surface of York 10 and a polarity may become opposite into next doors.

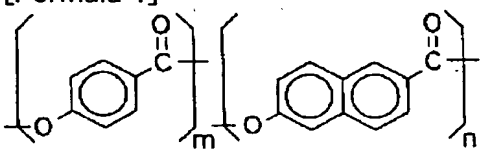
[0019] Moreover, the vibrating membrane by which 14 comes to form two or more curled form coils 18 corresponding to said two or more permanent magnets 12 in both sides of a base film 16, and 20 are frame type spacers (attachment component) which detach only a predetermined distance and hold vibrating membrane 14 from the pole face of a permanent magnet 12. Each curled form coil 18 of vibrating membrane 14 is formed so that the magnetic pole of the permanent magnet 12 of a base film 16 and the field which counters may be surrounded, and so that it may flow the adjoining side of the adjacent curled form coil 18 in the direction where a current is the same. It is formed with a concrete for example, circuit pattern like drawing 7 . As for a spacer 20, it is desirable to constitute, elastic ingredient, for example, chloroprene foam etc., etc. In addition, it is the hole which formed 22 in York 10 at the input terminal of a coil 18, and formed 24 for the air vent.

[0020] The description of this flat-surface loudspeaker is that the base film 16 which is the base material of vibrating membrane 14 consists of liquid crystal polymer films. Since the liquid crystal polymer film is excellent in thermal resistance, the dimensional stability (the coefficient of thermal expansion of 15-20 ppm/degree C, measurement result of 30 – 150 ** by the apparatus for thermomechanical analysis) which was excellent even if the curled form coil 18 carried out the temperature rise with the Joule's heat is shown, and coefficient of linear expansion is close to copper. Furthermore, since hygroscopicity is low (0.04% of water absorption, 23 degrees C, 24H), a liquid crystal polymer film is excellent in moisture absorption dimensional stability (rate of moisture absorption dimensional change 4 ppm/%RH in 60 degrees C), and even if it carries out long duration use, it does not almost have degradation of tone quality. Moreover, the absorption-of-sound nature of a liquid crystal polymer film is also high (tandelta=0.06). It is that and generating of a noise can be lessened.

[0021] As a liquid crystal polymer which constitutes the base film 16 of this flat-surface loudspeaker, the copolymerized polyester of the principal chain mold which contains as a principal component, the liquid crystal polymer (PHB), for example, Para-hydroxybenzoic acid, of all aromatic polyester systems, is desirable. The copoly ester types (trade name: Vectra etc.) of PHB and a 6-oxy—2-naphthoic acid are desirable especially. The chemical structure type of Vectra is as follows.

[0022]

[Formula 1]



[0023] Moreover, as for the base film 16 of this flat-surface loudspeaker, what carried out inflation molding of said liquid crystal polymer, and made orientation of a molecule isotropic in the direction of a field is desirable. After supplying a gas to that building envelope and making it expand with internal pressure, specifically extruding the fused liquid crystal polymer in the shape of a cylinder, forming a cylindrical film, and cooling this film, it is good to cut it open along with the direction of extrusion, to judge from what was used as the flat film-like film, and to consider as a base film 16.

[0024] Moreover, although it is also possible to adopt a subtractive process (how to carry out pattern etching of the copper-clad laminated film, and form a circuit pattern) as usual in order to form the curled form coil 18 on a liquid crystal polymer film, it is desirable to adopt an additive process (base film electroless deposition or the approach of forming a circuit pattern according to concomitant use of electroless deposition and electrolytic plating). In a subtractive process, the dimensional stability of a circuit pattern is low under the effect of side etching, and although it is difficult to make variation in the impedance of a coil small, if it is an additive process, since the dimensional stability of a circuit pattern is high, the variation in the impedance of a coil can be suppressed smaller.

[0025] [Operation gestalt 2] Drawing 2 (A) and (B) show other operation gestalten of this invention. With this operation gestalt, peripheral wall section 10a and shelf 10b are formed in the perimeter of the monotonous section of York 10 at one, and York 10 has become a shallow core box.
[0026] Moreover, the coat 26 is put on both sides of vibrating membrane 14 so that a base film 16 (liquid crystal polymer film) and the curled form coil 18 may be covered. This coat 26 presses down the curled form coil 18 to a base film 16, and serves to prevent that the curled form coil 18 exfoliates from a base film 16 by vibration. As a coat 26, an adhesive property with a liquid crystal polymer film is good, and can use the coating which consists of heat-resistant high insulating resin. For example, the coating of an alkyd-resin system, the thing which specifically denaturalized with the oil or the fatty acid on the basis of the alkyd resin (ester of polybasic acid, such as a phthalic acid, and polyhydric alcohol, such as a glycerol) can be used.
[0027] Moreover, vibrating membrane 14 is held in the periphery by the frame-like attachment component 28 which has elasticity. Wave section 28a to carry out adhesion immobilization of the inner circumference section at the periphery of vibrating membrane 14, carry out adhesion immobilization of the periphery section at shelf 10b of York 10, and for an attachment component 28 raise elasticity between the inner circumference section and the periphery section is formed. If vibrating membrane 14 is held by such attachment component 28, the reflected wave from the edge section by vibration of vibrating membrane 14 decreases, and improvement in tone quality can be aimed at.
[0028] Moreover, the buffer sheet 30 is stuck on the pole face of the York 10 and the opposite side of a permanent magnet 12, and Opening G is formed between this buffer sheet 30 and vibrating membrane 14. If it is made such a configuration, also when there is an opening G, vibration of vibrating membrane 14 is not checked, and there is a buffer sheet 30 and vibrating membrane 14 vibrates greatly to extent in contact with a permanent magnet 12, generating of a contact sound can be controlled. For this reason, improvement in tone quality and control of a noise can be aimed at. A nonwoven fabric, Japanese paper, etc. can be used as a buffer sheet 30.
[0029] in addition, the input terminal 22 of vibrating membrane 14 obtains that it is good for the external terminal 34 attached in the external surface of York 10 through the electric insulating plate 32, and is electrically connected to it by the conductor 36. As specifically shown in drawing 2 (C), through tube 16a is formed in the base film 16 of the part in which the input terminal 22 of vibrating membrane 14 was formed, and the patterns 22b and 22c of a front flesh side are combined by through hole plating 22d. It is preventing that an input terminal 22 exfoliates from a base film 16 by this. moreover, it obtains that it is good, and a conductor 36 pierces through through tube 16a, and is being fixed with solder 23. Since configurations other than the above are the same as the operation gestalt 1, the same sign is given to the same part and explanation is omitted.

[Translation done.]

EXAMPLE

[Example] [Example 1] The liquid crystal polymer film (Kuraray CT) with a thickness of 50 micrometers, the polyimide film, and the PET film were used for the base film of vibrating membrane, and the flat-surface loudspeaker with width of face of 40mm, a die length [of 140mm], and a thickness of 7mm was made as an experiment. To plate-like York 10 which formed the hole 24 like drawing 1 , with the square of 9mm around, the pole face has arranged 24 neodium magnets with a thickness of 3mm by arrangement of 2 train x12 line so that a polarity may become opposite into next doors.
[0031] The circuit pattern of vibrating membrane 14 was manufactured with the additive process. That is, wet-blasting processing was first performed to the base film as split-face-ized processing. Next, punching processing was performed in the location (the through hole section, terminal area) used as the double-sided flow section of a base film. Punching processing is performed to a terminal area for connecting a double-sided terminal area and raising the peel strength of a terminal area. Then, the vibrating membrane which has 20 curled form coils to both sides was manufactured through a non-electrolytic copper plating process, plating resist presswork, the electrolytic copper plating process, the plating resist removal process, the etching process, and the coat spreading process. The impedance between terminals was set as 6 ohms. As shown in drawing 1 , this vibrating membrane carried out adhesion immobilization of the spacer 20 which becomes the periphery section of plate-like York 10 from chloroprene foam with a thickness of 5mm, and carried out adhesion immobilization on that spacer 20. It considered as the structure which keeps constant the distance of vibrating membrane 14 and the pole face of a permanent magnet 12 by this.
[0032] About each flat-surface loudspeaker made as an experiment, the sinusoidal signal of 300 mV is added in 20kHz from 20Hz, and the result of having measured sound pressure-frequency characteristics is shown in drawing 3 and drawing 4 . Drawing 3 is the test result of the flat-surface loudspeaker of this invention which used the liquid crystal polymer film for the base film, and the sound pressure property before a carries out a heat cycle test and moisture resistance, and the sound pressure property after b carries out both trials are shown. A heat cycle test and moisture resistance are in the condition which impressed the white noise of 10W, and followed the conditions of automobile specification (JASO (D 001-94)). Both have almost lapped and it turns out that the flat-surface loudspeaker of this invention which used the liquid crystal polymer film for the base film does not almost have change in a sound pressure property before and behind a trial so that clearly from a and b of drawing 3 .
[0033] Drawing 4 is the test result of the flat-surface loudspeaker which used the polyimide film for the base film, and the sound pressure property before c carries out a heat cycle test and moisture resistance, and the sound pressure property after d carries out both trials are shown. A sound pressure property changes before and after a trial, and, as for the flat-surface loudspeaker which used the polyimide film for the base film, the fall of sound pressure is accepted after a trial. The flat-surface loudspeaker which used the PET film was also the same result as this.
[0034] [Example 2] Using three kinds of same base films as an example 1, the laminating of the copper foil with a thickness of 18 micrometers was carried out to both sides of each base film, and the curled form coil was formed in them with the subtractive process. It was made to flow through the through hole section electrically in coppering. The impedance between terminals was also set to

the same 6 ohms as an example 1. Thus, the flat-surface loudspeaker of the same size as an example 1 was made as an experiment using the manufactured vibrating membrane. As a result of measuring a sound pressure property about each flat-surface loudspeaker, the almost same property as drawing 3 was acquired, and the difference of the sound pressure property by the difference in the manufacture approach of vibrating membrane was not accepted. However, in the case of the subtractive process, compared with the case of an additive process, since the dimensional stability of a curled form coil was low, it was easy to generate variation in the impedance between terminals, and it turned out that it is difficult to manufacture a 6-ohm thing correctly.

[0035] [Example 3] The flat-surface loudspeaker which used the liquid crystal polymer film (Kuraray CT) with a thickness of 50 micrometers for the base film of vibrating membrane, and the flat-surface loudspeaker using an aramid nonwoven fabric reinforcement bridge formation polyester sheet (the Toyobo KOSUMO flex time) were made as an experiment. The curled form coil of vibrating membrane was formed with the subtractive process. The result of having measured the sound pressure property about these flat-surface loudspeakers is shown in drawing 5 . The sound pressure property of the flat-surface loudspeaker of this invention that a used the liquid crystal polymer film, and e are the sound pressure properties of the flat-surface loudspeaker of the example of a comparison which used the aramid nonwoven fabric reinforcement bridge formation polyester sheet. It turns out that the flat-surface loudspeaker of this invention is excellent in the sound pressure property of a loud-sound field compared with the flat-surface loudspeaker of the example of a comparison.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] (A) is the cross-sectional view [in / a top view and (B), and / in (C) / the C-C line of (B)] showing 1 operation gestalt of the flat-surface loudspeaker concerning this invention. [drawing of longitudinal section]
[Drawing 2] For a top view and (B), drawing of longitudinal section and (C) are [(A) which shows other same operation gestalten] the enlarged drawing of the C section in (B).
[Drawing 3] The graph which shows the temperature of the flat-surface loudspeaker of this invention, and the sound pressure property of moisture resistance before and the back.
[Drawing 4] The graph which shows the temperature of the flat-surface loudspeaker of the example of a comparison, and the sound pressure property of moisture resistance before and the back.
[Drawing 5] The graph which shows the sound pressure property of the flat-surface loudspeaker of this invention, and the flat-surface loudspeaker of other examples of a comparison.
[Drawing 6] Drawing of longitudinal section showing the principle of operation of a flat-surface loudspeaker.
[Drawing 7] The explanatory view showing the circuit pattern of the curled form coil of the vibrating membrane of a flat-surface loudspeaker.
[Description of Notations]
10: York
12: Permanent magnet
14: Vibrating membrane
16: Base film
18: Curled form coil
20: Spacer (attachment component)
22: Input terminal
24: Hole
26: Insulating coat
28: Attachment component
30: Buffer sheet

[Translation done.]

* NOTICES *

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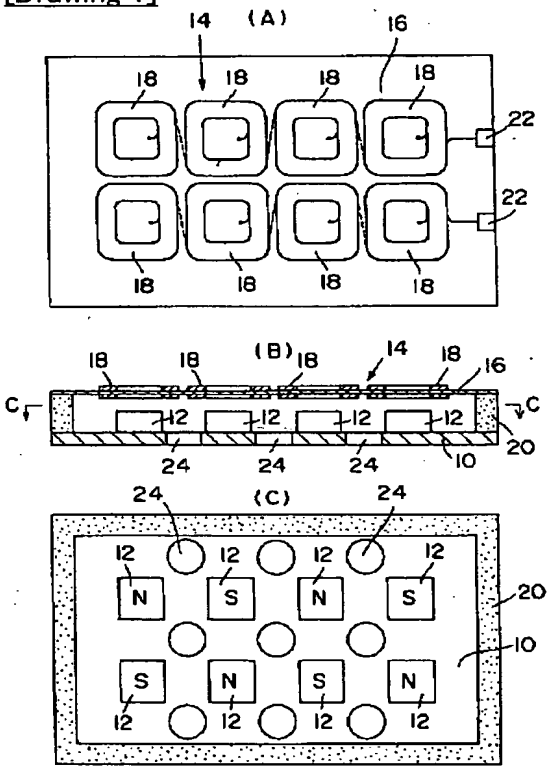
damages caused by the use of this translation.

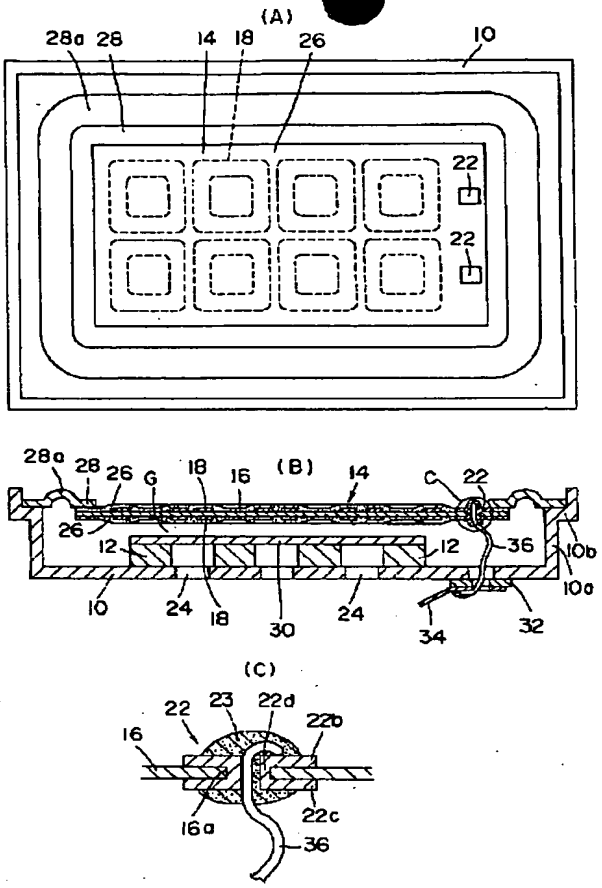
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

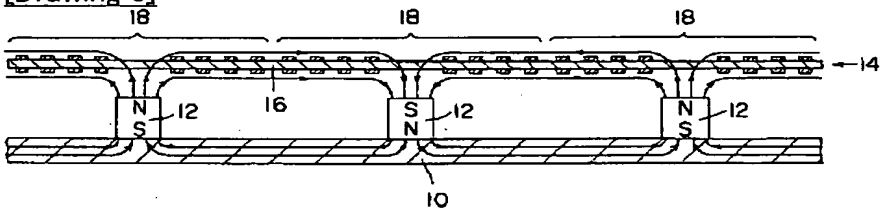
[Drawing 1]



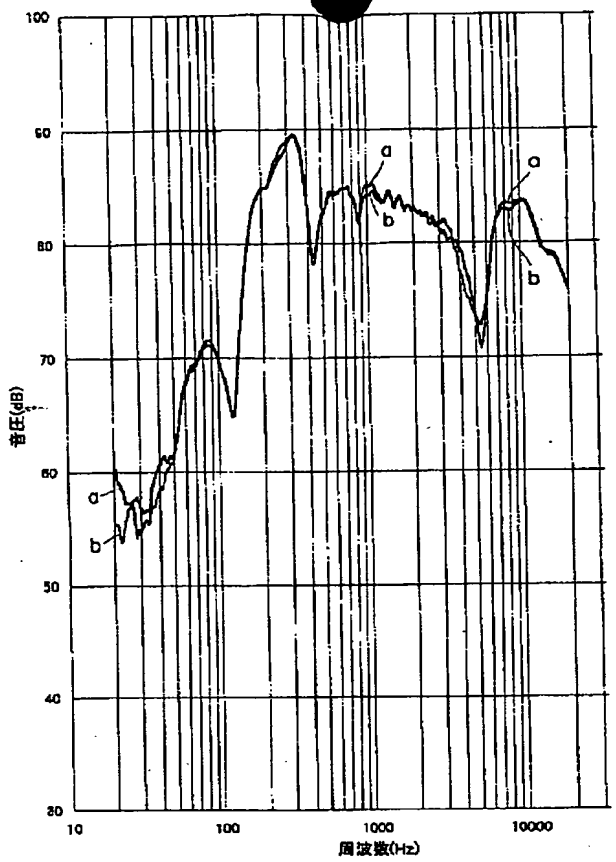
[Drawing 2]



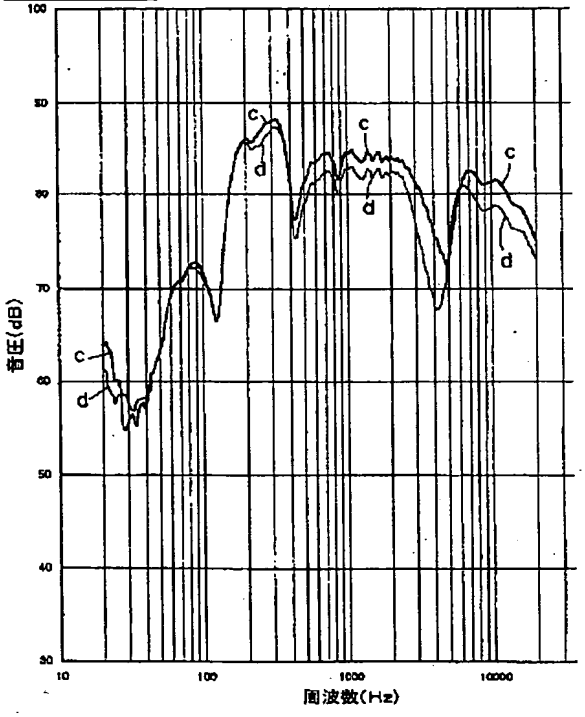
[Drawing 6]



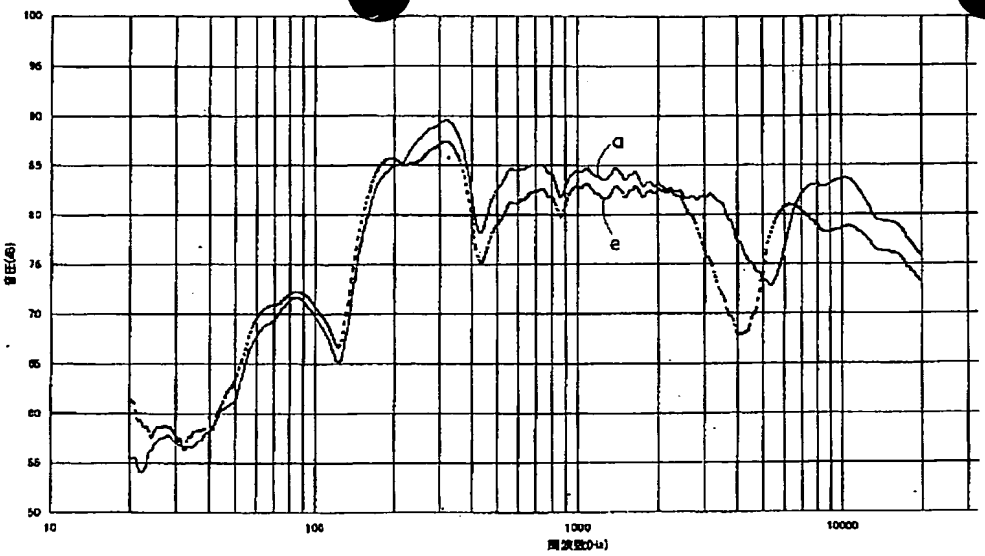
[Drawing 3]



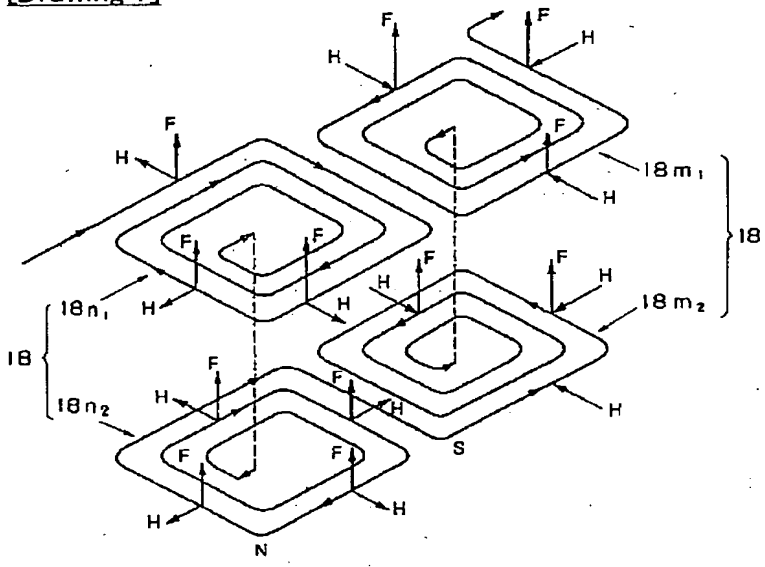
[Drawing 4]



[Drawing 5]



[Drawing 7]



[Translation done.]

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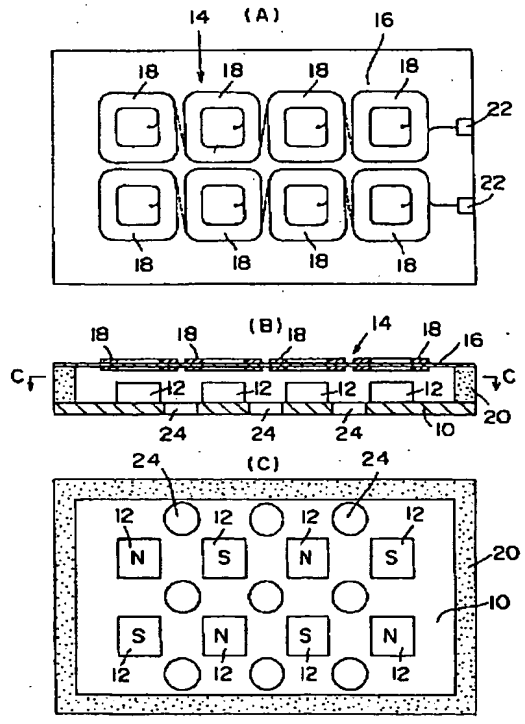
最終頁に続く

(54)【発明の名称】　平面スピーカ

(57)【要約】
【課題】　平板状のヨーク10と、ヨーク10の片面に、隣同士で極性が反対になるように取り付けられた複数の永久磁石12と、ベースフィルム16の両面に、複数の渦巻き状コイル18を、隣り合う渦巻き状コイルの隣接辺に電流が同じ方向に流れるように形成した振動膜14と、振動膜14を、永久磁石12の磁極面から所定の距離だけ離して保持するスペーサ20とを備えた平面スピーカにおいて、振動膜14のゆるみが発生しないようにして、音質の劣化を少なくする。
【解決手段】　振動膜14のベースフィルム16に液晶ポリマーフィルムを使用した。液晶ポリマーフィルムは、温度上昇に対しすぐれた寸法安定性を有し、通常の樹脂フィルムより吸湿性が格段に低いので、これをベースフィルムとして使用した振動膜は長期間の使用によってもゆるみが発生しにくく、音質の劣化を少なくできる。



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【特許請求の範囲】

【請求項１】少なくとも平板状部分を有するヨーク（10）と、

このヨーク（10）に取り付けられた永久磁石（12）と、絶縁性ベースフィルム（16）の片面又は両面に、前記永久磁石（12）に対応する渦巻き状コイル（18）を、前記永久磁石（12）の磁極と対向する領域を囲むように形成した振動膜（14）と、

この振動膜（14）を、前記永久磁石（12）のヨークと反対側の磁極面から所定の距離だけ離して保持する保持部材（20）とを備えた平面スピーカにおいて、

前記振動膜（14）のベースフィルム（16）が液晶ポリマーフィルムよりなることを特徴とする平面スピーカ。

【請求項２】永久磁石（12）のヨークと反対側の磁極面に緩衝シート（30）を張り付け、この緩衝シート（30）と振動膜（14）の間に空隙（G）を設けたことを特徴とする請求項１記載の平面スピーカ。

【請求項３】振動膜（14）の、渦巻き状コイル（18）が形成されている面に、渦巻き状コイル（18）及びベースフィルム（10）を覆うように被膜（26）を被着したことを特徴とする請求項１又は２記載の平面スピーカ。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、薄型の平面スピーカに関するものである。

【０００２】

【従来の技術】国際公開WO99/03304号公報には図６のような平面スピーカが開示されている。図において、10は鉄板（強磁性金属板）からなる平板状のヨーク、12はヨーク10の片面に磁軸を垂直にして取り付けられた複数の永久磁石である。永久磁石12はヨーク10の平面方向に所定の間隔をおいて隣同士で極性が反対になるように取り付けられている。

【０００３】また14は永久磁石12のヨーク10と反対側の磁極面から所定の距離だけ離して保持された振動膜である。この振動膜14は、絶縁性ベースフィルム16の両面（片面でも可）に、前記複数の永久磁石12に対応させて複数の渦巻き状コイル18を形成したものである。各渦巻き状コイル18は、永久磁石12の磁極と対向する領域を囲むように、かつ隣り合うコイルの隣接辺に電流が同じ方向に流れるように形成されている。

【０００４】渦巻き状コイル18の配線パターンは例えば図７のようになっている。$18n_1$ はベースフィルム16の表面に形成されたコイル、$18n_2$ はベースフィルムの裏面の同じ位置に形成されたコイルである。表面のコイル $18n_1$ は時計まわりで外側から内側へ行くように渦巻き状に形成され、裏面のコイル $18n_2$ は時計まわりで内側から外側へ行くように渦巻き状に形成され、両コイル $18n_1$ 、$18n_2$ の内端はベースフィルムを貫通するスルーホール又はスルースタッドで導通している。したがって

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両コイル $18n_1$ 、$18n_2$ は巻回方向が時計まわりの一つのコイル18を構成している。

【０００５】また $18m_1$ はベースフィルム16の表面に前記コイル $18n_1$ と隣り合うように形成されたコイル、$18m_2$ はベースフィルム16の裏面に前記コイル $18n_2$ と隣り合うように形成されたコイルである。裏面のコイル $18m_2$ は外端が隣りのコイル $18n_2$ と連続していて、反時計まわりで外側から内側へ行くように渦巻き状に形成され、表面のコイル $18m_1$ は反時計まわりで内側から外側へ行くように渦巻き状に形成され、両コイル $18m_1$ 、$18m_2$ の内端はベースフィルムを貫通するスルーホール又はスルースタッドで導通している。したがって両コイル $18m_1$ 、$18m_2$ は巻回方向が反時計まわりの一つのコイル18を構成している。

【０００６】このような形で複数の渦巻き状コイル18を一筆書き状に形成すると、隣り合うコイル18、18の隣接辺には電流が同じ方向に流れることになる。一方、各コイル18は図６に示すように互いに隣り合う極性の異なる永久磁石12によって形成される磁界中に置かれるので、隣り合うコイル18の隣接辺に同じ方向に電流が流れると、振動膜14はフレミングの左手の法則により電磁力を受けることになる。図７において、Hは永久磁石12の磁極N、Sにより形成される磁界であり、この状態でコイル18に矢印方向の電流が流れると、F方向の力が発生することになる。このため振動膜14はコイル18に流れる音声電流によって振動する。

【０００７】以上のようなタイプの平面スピーカは、厚さを５～15㎜程度に薄くできることから、壁掛けテレビやノートパソコン等に好適である。また自動車のピラーやサンバイザー等への組み込みも可能となる。

【０００８】

【発明が解決しようとする課題】しかしながら上記タイプの平面スピーカは、振動膜の大部分の領域を渦巻き状コイルが占めており、各コイルがジュール熱で発熱するため、振動膜の基材であるベースフィルムへの熱の影響を無視できない。このためベースフィルムには耐熱性のよいポリイミドフィルムを使用することが提案されているが、ポリイミドフィルムは $\tan\delta = 0.02$ と吸音性が低く、振動膜が振動したときに雑音が発生しやすいという問題がある。またポリイミドフィルムは吸湿性を有することから、吸湿による僅かな伸びに起因する音質の変化が予想される。

【０００９】またベースフィルムに、ＰＥＴ（ポリエチレンテレフタレート）フィルムを使用することも提案されているが、ＰＥＴフィルムも $\tan\delta = 0.014$ と吸音性が低く、振動膜が振動したときに雑音が発生しやすいという問題がある。

【００１０】また上記タイプの平面スピーカは、振動膜が大きく振動したときに永久磁石と接触し、雑音を発生することがある。この問題は、前述したコイルの発熱に

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より振動膜にゆるみが発生すると、顕著になる。これを防止する手段としては振動膜と永久磁石の間に発泡ウレタンやグラスウール等の軟質材を介在させることも公知であるが、このような軟質材を介在させることは、振動膜の自由な振動を妨げることになり、音質を低下させる要因となる。

【００１１】またベースフィルムの片面又は両面に複数の渦巻き状コイルを形成した振動膜は、通常のフレキシブルプリント回路基板の製造技術によって製造できるが、振動膜の場合は、コイルが電磁力を受けて厚さ方向に激しく振動することから、ベースフィルムとコイルとの接着力がかなり強くないと、コイルがベースフィルムから剥離するおそれがある。コイルの剥離を防ぐには、ベースフィルム表面を粗面化して単位面積あたりの接着力を高めるか、コイルの導体幅を広くすることが有効であるが、前者は振動特性向上のため薄いベースフィルムを用いると限界があり、後者は平面スピーカの大型化を招くので好ましくない。

【００１２】以上のような問題点に鑑み、本発明の第一の目的は、振動膜のゆるみが発生しにくい、したがって音質の劣化が少ない平面スピーカを提供することにある。本発明の第二の目的は、振動膜と永久磁石の接触音をなくし、しかも振動膜の自由な振動を妨げることのない平面スピーカを提供することにある。本発明の第三の目的は、振動膜の渦巻き状コイルがベースフィルムから剥離するおそれの少ない、信頼性の高い平面スピーカを提供することにある。

【００１３】

【課題を解決するための手段】前記第一の目的を達成するため、本発明は、少なくとも平板状部分を有するヨークと、このヨークに取り付けられた永久磁石と、絶縁性ベースフィルムの片面又は両面に、前記永久磁石に対応する渦巻き状コイルを、前記永久磁石の磁極と対向する領域を囲むように形成した振動膜と、この振動膜を、前記永久磁石のヨークと反対側の磁極面から所定の距離だけ離して保持する保持部材とを備えた平面スピーカにおいて、前記振動膜のベースフィルムが液晶ポリマーフィルムよりなることを特徴とするものである。

【００１４】より具体的には本発明は、少なくとも平板状部分を有するヨークと、このヨークの平板状部分の片面に、磁軸が垂直になるように、かつ隣同士で極性が反対になるように取り付けられた複数の永久磁石と、絶縁性ベースフィルムの片面又は両面に、前記複数の永久磁石に対応する複数の渦巻き状コイルを、前記永久磁石の磁極と対向する領域を囲むように、かつ隣り合う渦巻き状コイルの隣接辺に電流が同じ方向に流れるように形成した振動膜と、この振動膜を、前記複数の永久磁石のヨークと反対側の磁極面から所定の距離だけ離して保持する保持部材とを備えた平面スピーカにおいて、前記振動膜のベースフィルムを液晶ポリマーフィルムで構成したことを特徴とするものである。

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【００１５】液晶ポリマーフィルムは、温度上昇に対しすぐれた寸法安定性を有し、通常の樹脂フィルムより吸湿性が格段に低い（例えば吸湿膨張率はポリイミドが2.9％であるのに対し液晶ポリマーは0.04％である）ので、これをベースフィルムとして使用した振動膜は長期間の使用によってもゆるみが発生しにくく、音質の劣化を少なくできる。また液晶ポリマーフィルムは tanδ（内部損失、吸音性）が高いので、雑音が発生しにくいという利点もある。

【００１６】また本発明は、前記第二の目的を達成するため、上記構成の平面スピーカにおいて、永久磁石のヨークと反対側の磁極面に緩衝シートを張り付け、この緩衝シートと振動膜の間に空隙を設けたことを特徴とするものである。このようにすれば、振動膜は自由な振動を妨げられることがなく、しかも磁極面に接触するような振幅になっても緩衝シートの働きで接触音の発生を抑制できる。

【００１７】また本発明は、前記第三の目的を達成するため、上記構成の平面スピーカにおいて、振動膜の、渦巻き状コイルが形成されている面に、渦巻き状コイル及びベースフィルムを覆うように被膜を被着したことを特徴とするものである。このようにすると被膜によって渦巻き状コイルがベースフィルムに押さえつけられた状態となるので、激しい振動を受けてもコイルがベースフィルムから剥離するおそれが少なくなる。

【００１８】

【発明の実施の形態】以下、本発明の実施形態を図面を参照して詳細に説明する。

〔実施形態１〕図１（Ａ）～（Ｃ）は本発明の一実施形態を示す。図において、10は鉄板等からなる平板状のヨーク、12はヨーク10の片面に磁軸を垂直にして取り付けられた複数の永久磁石である。永久磁石12はヨーク10の平面方向に所定の間隔をおいて隣同士で極性が反対になるように取り付けられている。

【００１９】また14はベースフィルム16の両面に前記複数の永久磁石12に対応する複数の渦巻き状コイル18を形成してなる振動膜、20は振動膜14を永久磁石12の磁極面から所定の距離だけ離して保持する枠型のスペーサ（保持部材）である。振動膜14の各渦巻き状コイル18は、ベースフィルム16の永久磁石12の磁極と対向する領域を囲むように、かつ隣り合う渦巻き状コイル18の隣接辺に電流が同じ方向に流れるように形成されている。具体的には例えば図７のような配線パターンで形成されている。スペーサ20は弾力性のある材料例えばクロロプレン発泡体などで構成することが好ましい。なお、22はコイル18の入力端子、24はヨーク10に空気抜きのために形成した穴である。

【００２０】この平面スピーカの特徴は、振動膜14の基材であるベースフィルム16が液晶ポリマーフィルムで構

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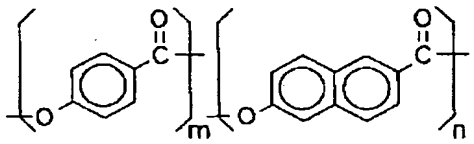
成されていることである。液晶ポリマーフィルムは、耐熱性にすぐれているため、渦巻き状コイル18がジュール熱で温度上昇してもすぐれた寸法安定性（熱膨張係数15～20ｐｐｍ／℃、熱機械分析装置による30～150 ℃の測定結果）を示し、線膨張係数は銅に近い。さらに液晶ポリマーフィルムは吸湿性が低い（吸水率0.04%、23℃、24H）ことから、吸湿寸法安定性にすぐれ（60℃における吸湿寸法変化率4 ppm／%RH）、長時間使用しても音質の劣化がほとんどない。また液晶ポリマーフィルムは吸音性も高い(tanδ＝0.06）ので、雑音の発生を少なくできる。

【００２１】この平面スピーカのベースフィルム16を構成する液晶ポリマーとしては、全芳香族ポリエステル系の液晶ポリマー、例えばパラーヒドロキシ安息香酸（ＰＨＢ）を主成分として含む主鎖型の共重合ポリエステルが好ましい。中でもＰＨＢと６－オキシ－２－ナフトエ酸のコポリエステルタイプ（商品名：ベクトラ等）が好ましい。ベクトラの化学構造式は次のとおりである。

【００２２】

【化１】



【００２３】また、この平面スピーカのベースフィルム16は、前記液晶ポリマーをインフレーション成形して分子の配向を面方向に等方的にしたものが好ましい。具体的には、溶融した液晶ポリマーを円筒状に押し出して円筒状フィルムを形成し、このフィルムを冷却しながらその内部空間に気体を供給して、内圧により膨張させた後、押出方向に沿って切開して、平膜状フィルムとしたものから裁断して、ベースフィルム16とするとよい。

【００２４】また液晶ポリマーフィルム上に渦巻き状コイル18を形成するには、従来同様サブトラクティブ法（銅張り積層フィルムをパターンエッチングして配線パターンを形成する方法）を採用することも可能であるが、アディティブ法（ベースフィルムに無電解メッキにより又は無電解メッキと電解メッキの併用により配線パターンを形成する方法）を採用することが好ましい。サブトラクティブ法ではサイドエッチングの影響で配線パターンの寸法安定性が低く、コイルのインピーダンスのバラツキを小さくすることが困難であるが、アディティブ法であれば、配線パターンの寸法安定性が高いので、コイルのインピーダンスのバラツキをより小さく抑えることができる。

【００２５】〔実施形態２〕図２（Ａ）、（Ｂ）は本発明の他の実施形態を示す。この実施形態では、ヨーク10の平板部の周囲に周壁部10ａと棚部10ｂが一体に形成され、ヨーク10が浅い箱型になっている。

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【００２６】また振動膜14の両面には、ベースフィルム16（液晶ポリマーフィルム）及び渦巻き状コイル18を覆うように被膜26が被着されている。この被膜26は、渦巻き状コイル18をベースフィルム16に押さえつけて、振動によって渦巻き状コイル18がベースフィルム16から剥離するのを阻止する働きをする。被膜26としては、液晶ポリマーフィルムとの接着性がよく、耐熱性の高い絶縁性の樹脂からなる塗料を利用できる。例えばアルキッド樹脂系の塗料、具体的にはアルキッド樹脂（フタル酸等の多塩基酸とグリセリン等の多価アルコールとのエステル）を基本とし、油や脂肪酸で変性したものなどを使用することができる。

【００２７】また振動膜14はその周辺部を弾性を有する額縁状の保持部材28によって保持されている。保持部材28は、内周部が振動膜14の周辺部に接着固定され、外周部がヨーク10の棚部10ｂに接着固定され、内周部と外周部の間に弾性を高めるための波形部28ａが形成されているものである。このような保持部材28によって振動膜14を保持すると、振動膜14の振動によるエッジ部からの反射波が少なくなり、音質の向上を図ることができる。

【００２８】また永久磁石12の、ヨーク10と反対側の磁極面には、緩衝シート30が張り付けられ、この緩衝シート30と振動膜14の間に空隙Ｇが設けられている。このような構成にしておくと、空隙Ｇがあることにより振動膜14の振動が阻害されることがなく、かつ緩衝シート30があることにより振動膜14が永久磁石12に接触する程度に大きく振動した場合にも接触音の発生を抑制できる。このため音質の向上、雑音の抑制を図ることができる。緩衝シート30としては不織布や和紙などを使用することができる。

【００２９】なお、振動膜14の入力端子22は、ヨーク10の外面に絶縁板32を介して取り付けられた外部端子34に、可とう導体36により電気的に接続されている。具体的には図２（Ｃ）に示すように、振動膜14の入力端子22を形成した部分のベースフィルム16には貫通孔16ａが形成されており、表裏のパターン22ｂ、22ｃがスルーホールメッキ22ｄで結合されている。これにより入力端子22がベースフィルム16から剥離するのを予防している。また可とう導体36は貫通孔16ａを貫き、半田23で固定されている。上記以外の構成は実施形態１と同じであるので、同一部分には同一符号を付して説明を省略する。

【００３０】

【実施例】〔実施例１〕振動膜のベースフィルムに、厚さ50μｍの液晶ポリマーフィルム（クラレＣＴ）、ポリイミドフィルム、ＰＥＴフィルムを用いて、幅40㎜、長さ140㎜、厚さ７㎜の平面スピーカを試作した。図１のように穴24を形成した平板状のヨーク10に、磁極面が９㎜四方の正方形で厚さ３㎜のネオジウム磁石を、２列×12行の配置で、極性が隣同士で反対になるように24個配置した。

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【００３１】振動膜14の配線パターンはアディティブ法により製造した。すなわち、まずベースフィルムに粗面化処理としてウェットブラスト処理を施した。次にベースフィルムの両面導通部となる位置（スルーホール部、端子部）に穴あけ処理を行った。端子部に穴あけ処理を行うのは、両面の端子部を連結して端子部の剥離強度を高めるためである。その後、無電解銅メッキ工程、メッキレジスト印刷工程、電解銅メッキ工程、メッキレジスト除去工程、エッチング工程、被膜塗布工程を経て、両面に20個の渦巻き状コイルを有する振動膜を製造した。端子間のインピーダンスは６Ωに設定した。この振動膜は、図１に示すように、平板状のヨーク10の外周部に厚さ５㎜のクロロプレン発泡体よりなるスペーサ20を接着固定し、そのスペーサ20の上に接着固定した。これにより振動膜14と永久磁石12の磁極面との距離を一定に保つ構造とした。

【００３２】試作した各平面スピーカについて、20Ｈｚから20ｋＨｚの範囲で300 ｍＶの正弦波信号を加え、音圧－周波数特性を測定した結果を図３及び図４に示す。図３はベースフィルムに液晶ポリマーフィルムを使用した本発明の平面スピーカの試験結果で、ａは温度サイクル試験及び温湿度サイクル試験を実施する前の音圧特性、ｂは両試験を実施した後の音圧特性を示す。温度サイクル試験及び温湿度サイクル試験は、10Wのホワイトノイズを印加した状態で、自動車規格（ＪＡＳＯ（Ｄ００１－９４））の条件に従った。図３のａとｂから明らかなように、両者はほとんど重なっており、ベースフィルムに液晶ポリマーフィルムを使用した本発明の平面スピーカは試験の前後で音圧特性にほとんど変化がないことが分かる。

【００３３】図４はベースフィルムにポリイミドフィルムを使用した平面スピーカの試験結果で、ｃは温度サイクル試験及び温湿度サイクル試験を実施する前の音圧特性、ｄは両試験を実施した後の音圧特性を示す。ベースフィルムにポリイミドフィルムを使用した平面スピーカは試験の前後で音圧特性が変化し、試験後に音圧の低下が認められる。ＰＥＴフィルムを使用した平面スピーカも、これと同様な結果であった。

【００３４】〔実施例２〕実施例１と同じ３種類のベースフィルムを用い、各ベースフィルムの両面に厚さ18μｍの銅箔を積層して、サブトラクティブ法により渦巻き状コイルを形成した。スルーホール部は銅メッキで電気的に導通させた。端子間のインピーダンスも実施例１と同じ６Ωとした。このようにして製造した振動膜を用いて実施例１と同じサイズの平面スピーカを試作した。各平面スピーカについて音圧特性を測定した結果、図３とほぼ同じ特性が得られ、振動膜の製造方法の違いによる音圧特性の差は認められなかった。ただしサブトラクティブ法の場合は、アディティブ法の場合に比べ、渦巻き状コイルの寸法安定性が低いため、端子間のインピーダンスにバラツキが発生しやすく、正確に６Ωのものを製造することが困難であることが分かった。

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【００３５】〔実施例３〕振動膜のベースフィルムに、厚さ50μｍの液晶ポリマーフィルム（クラレＣＴ）を用いた平面スピーカと、アラミッド不織布補強架橋ポリエステルシート（東洋紡コスモフレックス）を用いた平面スピーカを試作した。振動膜の渦巻き状コイルはサブトラクティブ法により形成した。これらの平面スピーカについて音圧特性を測定した結果を図５に示す。ａは液晶ポリマーフィルムを使用した本発明の平面スピーカの音圧特性、ｅはアラミッド不織布補強架橋ポリエステルシートを使用した比較例の平面スピーカの音圧特性である。本発明の平面スピーカは比較例の平面スピーカに比べて、高音領域の音圧特性がすぐれていることが分かる。

【００３６】

【発明の効果】以上説明したように本発明によれば、振動膜のベースフィルムに液晶ポリマーフィルムを使用したことにより、湿度の高い環境下におかれても振動膜のゆるみが発生しにくい、したがって音質の劣化が少ない平面スピーカを得ることができる。

【００３７】また永久磁石のヨークと反対側の磁極面に緩衝シートを張り付け、この緩衝シートと振動膜の間に空隙を設けることにより、振動膜と永久磁石の接触音をなくし、しかも振動膜の自由な振動を妨げることのない平面スピーカを得ることができる。

【００３８】さらに振動膜の表面に、ベースフィルム及び渦巻き状コイルを覆うように被膜を被着することにより、渦巻き状コイルがベースフィルムから剥離するおそれの少ない、信頼性の高い平面スピーカを得ることができる。

【図面の簡単な説明】

【図１】　本発明に係る平面スピーカの一実施形態を示す、（Ａ）は平面図、（Ｂ）は縦断面図、（Ｃ）は（Ｂ）のＣ－Ｃ線における横断面図。

【図２】　同じく他の実施形態を示す、（Ａ）は平面図、（Ｂ）は縦断面図、（Ｃ）は（Ｂ）中のＣ部の拡大図。

【図３】　本発明の平面スピーカの、温度及び温湿度サイクル試験の前と後の音圧特性を示すグラフ。

【図４】　比較例の平面スピーカの、温度及び温湿度サイクル試験の前と後の音圧特性を示すグラフ。

【図５】　本発明の平面スピーカと、他の比較例の平面スピーカの音圧特性を示すグラフ。

【図６】　平面スピーカの動作原理を示す縦断面図。

【図７】　平面スピーカの振動膜の渦巻き状コイルの配線パターンを示す説明図。

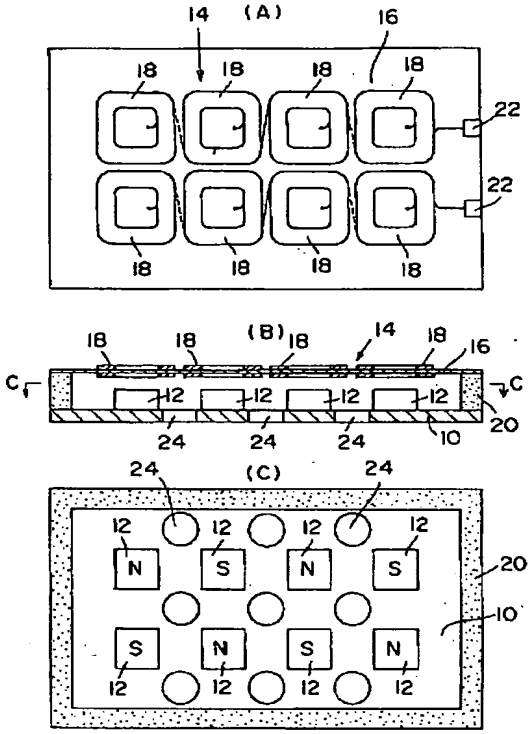
【符号の説明】

10：ヨーク

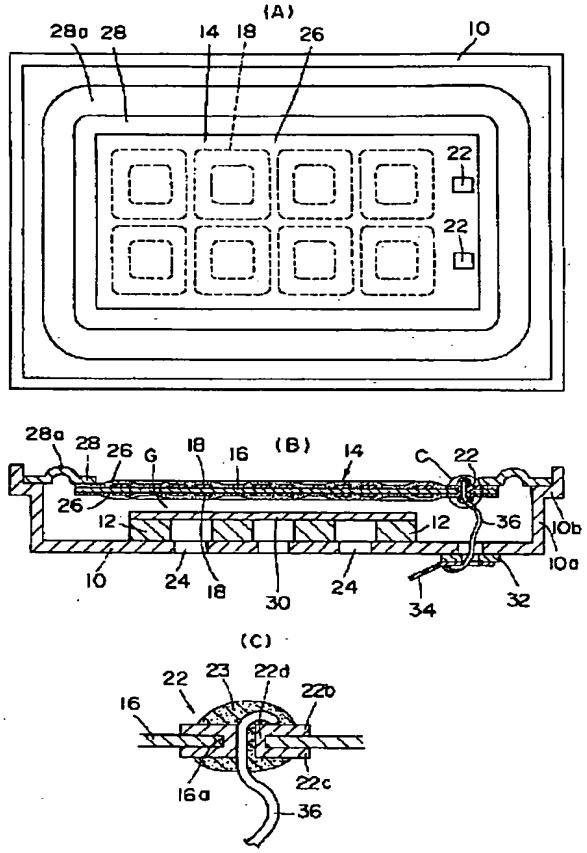
12：永久磁石

14：振動膜
16：ベースフィルム
18：渦巻き状コイル
20：スペーサ（保持部材）
22：入力端子
24：穴
26：絶縁被膜
28：保持部材
30：緩衝シート

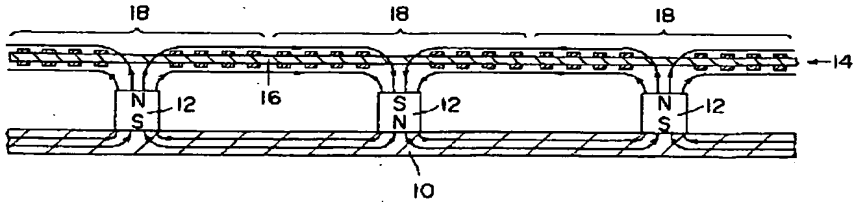
【図１】



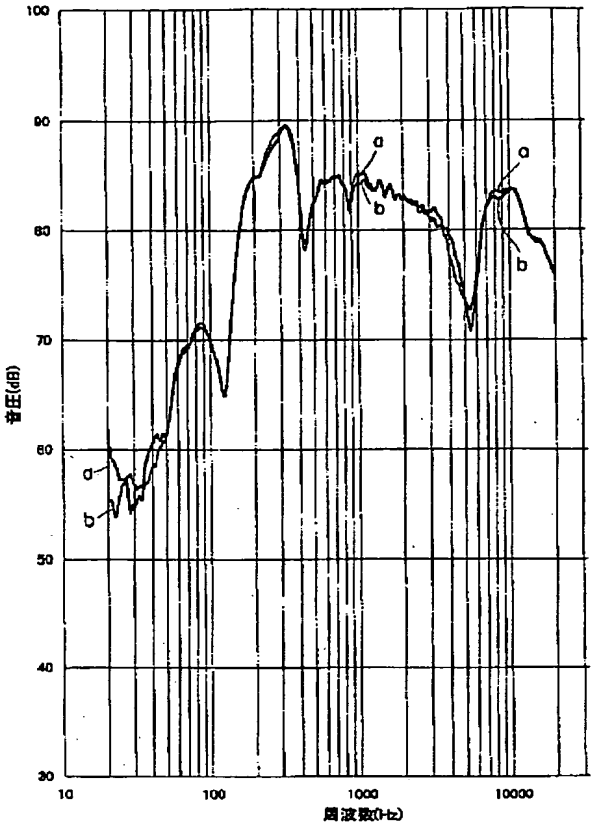
【図２】



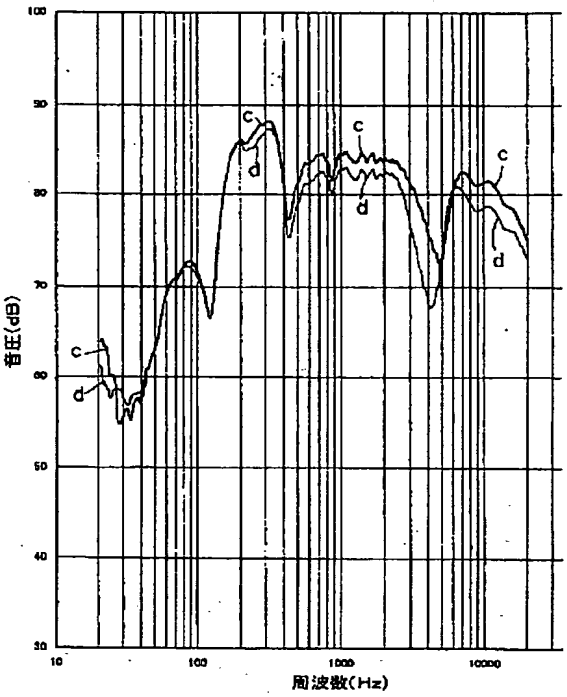
【図６】



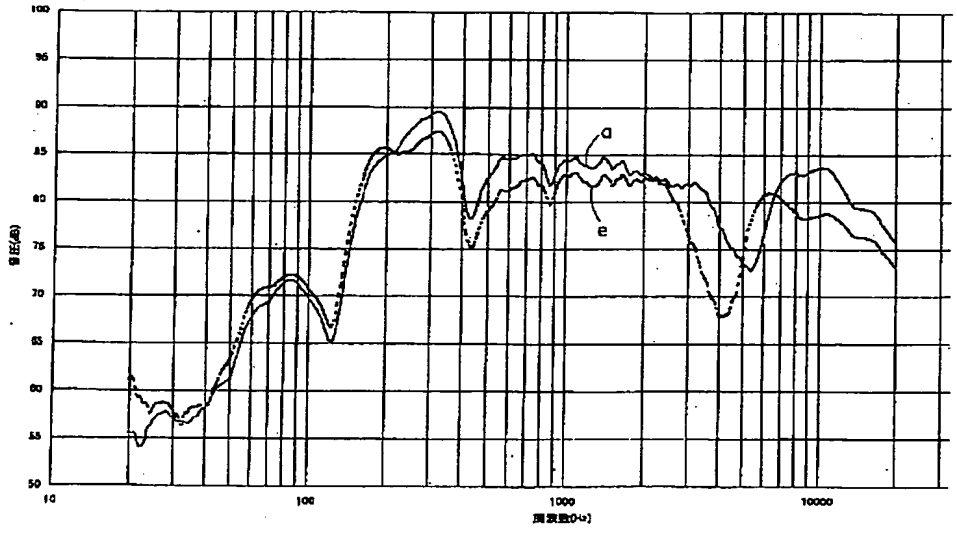
【図３】



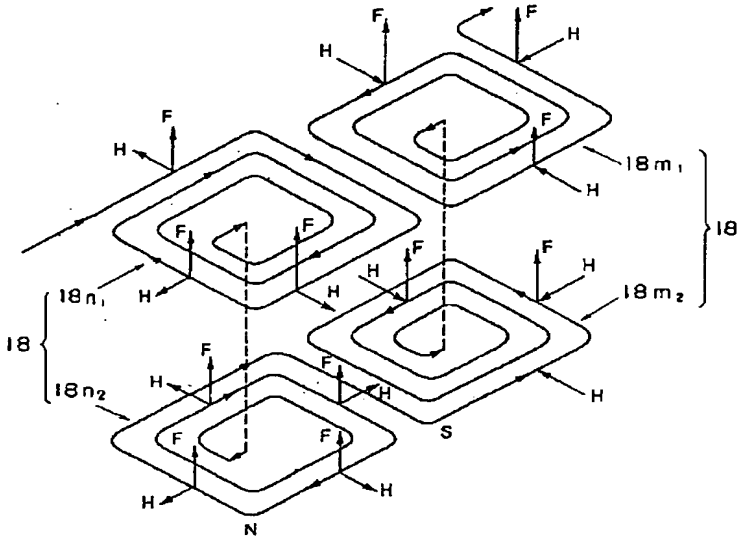
【図４】



【図５】



【図７】



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